REMARKS

By the above amendment, Applicant has amended the specification and all the claims to clarify that the representation of Boolean functions and Boolean simplification in this invention are computer-oriented and must be suitable for complex Boolean functions, but must not be based on Binary Decision Diagrams. Applicant appreciates the discussions in the Office Actions on Okuzawa's method using Binary Decision Diagrams and on the Boolean minimization techniques that are not computer-oriented and are not suitable for complex Boolean functions.

With this clarification, it is clearer that the claimed invention has novel physical features that are not disclosed in the combination of references suggested in the Office Actions, and the novel physical features are not obvious.

The Rejection Of Claim 1 On Okuzawa, Tucker and MPEP 2144.04(VI)(B) Is Overcome

The Final Action and the 2 Advisory Actions rejected independent claim 1 under 35 U.S.C. 103(a) over Okuzawa in view of Tucker and MPEP 2144.04(VI)(B) legal precedent for duplication. Claim 1 has been amended to define patentably over these references, and any combination thereof. Applicant requests reconsideration of this rejection for the following reasons:

(1) There is no justification, in Okuzawa, Tucker and MPEP 2144.04(VI)(B), or in any other prior art separate from applicant's disclosure, which suggests that these references be combined, much less combined in the manner suggested in the Office Actions.

(2) The combination suggested in the Office Actions would not be physically possible or operative.

(3) Even if Okuzawa, Tucker and MPEP 2144.04(VI)(B) are combined in the manner suggested in the Office Actions, the combination would not show all of the novel physical features in claim 1.

(4) These novel physical features of claim 1 produce new and unexpected results and hence are unobvious and patentable over these references.

The References And Differences Of The Present Invention Thereover

Prior to discussing the claims and the above four points, applicant will first discuss the references and the general novelty of the present invention and its unobviousness over the references.

Okuzawa's basic idea of comparing 2 Boolean functions is that the comparison is easy after transforming both Boolean functions. This requires transformations of special features if the Boolean functions are too large to be represented as truth tables. Such special transformations exist for Binary Decision Diagrams. It is well known in the art that such transformations do not exist for Boolean expressions and other popular representations of Boolean functions.

Therefore, Okuzawa's "transform and compare" do not generally work for Boolean expressions or other popular representations of Boolean functions because the comparison is not guaranteed to be easier after normal transformations of them.

The desired transformations for Binary Decision Diagrams make the comparison very easy, but they are complicated themselves. Sometimes they fail for large Boolean functions because they require too much time or too much computer memory. The final comparison step cannot even start if these transformations fail.

Because the comparison is already easy after the transformations, "divide and conquer" does not make it easier. Here, "divide and conquer" is about making the comparison easier. Actually, when the transformations are too complex to finish, "divide and conquer" makes these transformations even more complex because it requires more application rounds of these transformations.

The present invention stays away from the "transform and compare" style by using normal transformations and normal (natural) representations of Boolean functions. This choice makes "divide and conquer" helpful to reduce the required computer memory. For large Boolean functions, it can still take too much time. Parallel processing is a popular idea to shorten the required time.

As disclosed in Tucker, second last paragraph on page 2034, "The difficult part is determining the appropriate granularity of the parallel version of the

program." It is well known in the art (as asserted in Okuzawa, column 1, lines 54-57), it is inferior to compare "a single input point at a time" as suggested in the Final Action, paragraph 42. There were no known methods in the prior art to divide the comparison problem at various other granularity levels for parallel processing. Therefore, it was well known in the art that "transform and compare" was better than "divide and conquer".

The present invention introduces the concept of "subsets of input space" as a novel physical feature into this context, with novel means to represent and manipulate the subsets efficiently. These novel features enable parallel processing of the comparison at various granularity levels. Also by switching to Tautology Checking, the efficiency can be further improved, while the prior art did not show any advantage of Tautology Checking. These novel physical features enable "divide and conquer" at various granularity levels, and they also improve the efficiency significantly by automatically finding the optimal granularity levels.

Okuzawa, Tucker and MPEP 2144.04(VI)(B) Do Not Contain Any Justification to Support Their Combination, Much Less The Manner Suggested In the Office Actions

With regard to the combination of Okuzawa, Tucker and MPEP 2144.04(VI)(B), it is well known that in order for any prior-art U.S.C 103 rejection, the reference themselves (or some other prior art) must suggest that they be combined. E.g. as was stated in In re Sernaker, 217 U.S.P.Q. 1, 6 (C.A.F.C. 1983):

"[P]rior art references in combination do not make any invention obvious unless something in the prior art references would suggest the advantage to be derived from combining their teachings."

The the suggestion to combine the references should not come from applicant was forcefully stated in Orthopedic Equipment Co. v. United States, 217 U.S.P.Q. 193, 199 (C.A.F.C. 1983):

"It is wrong to use the patent in suit [here the patent application] as a guide through the maze of prior art references, combining the right references in the right way to achieve the result of the claims in suit [here the claims pending]. Monday morning quarterbacking is quite improper when solving the question of nonobviousness in a court of law [here the PTO]."

As was further stated in Uniroyal, Inc. v. Rudkin-Wiley Corp., 5 U.S.P.Q.2d 1434 [C.A.F.C. 1988], "[w]here prior-art references require selective combination by the court to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gleaned from the invention itself. ... *Something in the prior art must suggest the desirability and thus the obviousness of making the combination.*" [Emphasis supplied.]

In line with these decisions, more recently the Board stated in Ex parte Levengood, 28 U.S.P.Q.2d 1300 [B.P.A.&I. 1993]:

"In order to establish a *prima facie* case of obviousness, it is necessary for the examiner to present *evidence*, preferably in the form of some teaching, suggestion, incentive or inference in the applied prior art, or in the form of generally available knowledge, that one having ordinary skill in the art *would have been led* to combine the relevant teachings of the applied references in the proposed manner to arrive at the claimed invention. ... That which is within the capabilities of one skilled in the art is not synonymous with obviousness. ... That one can *reconstruct* and/or explain the theoretical mechanism of an invention by means of logic and sound scientific reasoning does not afford the basis for an obviousness conclusion unless that logic and reasoning also supplies sufficient impetus to have led one of ordinary skill in the art to combine the teachings of the references to make the claimed invention. ... Our reviewing court have often advised the Patent and Trademark Office that it can satisfy the burden of establishing a *prima facie* case of obviousness only by showing some objective teaching in either the prior art, or knowledge generally available to one of ordinary kill in the art, that 'would lead' that individual 'to combine the relevant teachings of the references.' ... Accordingly, an examiner cannot establish obviousness by locating references which describe various aspects of a patent applicant's invention without also providing evidence of the motivating force which would impel one skill in the art to do what the patent applicant has done."

In the present case, the references only suggest a different manner of combining the references, and the Office Actions present only erroneous lines of reasoning as to

why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references.

The only suggestion of applying "divide and conquer" techniques in Okuzawa (without enabling details) is at Column 4 lines 61-63: "... and thus this method can be applied to a large scale LSI when a division hierarchy design where the LSI is treated as divided small circuits is adopted." This suggestion does not involve the "mere duplication" in MPEP 2144.04(VI)(B), and it teaches away from the manner of applying "divide and conquer" techniques in the present invention.

In the first Advisory Action, the first paragraph on page 3, it is asserted **without any documentary evidence** that "the division of input space into simpler subsets appears well known in the art. ... For example, one of ordinary skill in the art would interpret the cited art in the view of well known Boolean input space divisional techniques such as Boolean minimization using theorems, or using Karnaugh map graphical techniques." These techniques are well known but not as "Boolean input space divisional techniques" and there were no well known computer-based techniques to divide input space of a complex Boolean function into simpler subsets. Karnaugh map graphical techniques are only known as manual methods, but the present invention, Okuzawa and Tucker are all clearly **computer-based** methods. Karnaugh map graphical techniques are also known not to work on **complex Boolean functions** because a Karnaugh map can show at most 4 or 5 Boolean variables. The newly amended specification and claims make it clearer that the

present invention is computer-based and on complex Boolean functions although it was already clear in the background and the detailed description sections of the original specification (the first full paragraph on page 3 and the last paragraph on page 12). **Applicant demands the Examiner to produce authority for his statement** per MPEP 2144.03(C). According to MPEP 2144.3(A), "Official notice unsupported by documentary evidence should only be taken by the examiner where the facts asserted to be well-known, or to be common knowledge in the art are capable of instant and unquestionable demonstration as being well-known."

As the only earlier line of reasoning related to rejecting claim 1, the motivation "to use Tucker and MPEP 2144.04(VI)(B) to modify Okuzawa" presented in the Final Action, paragraph 42, is "to simplify the equivalence comparison by comparing a single logical expression at a time (Tucker) or a single input point at a time (MPEP 2144.04(VI)(B)), and thus to reduce the resources required (such as RAM) to perform the equivalence comparison, and/or to speed calculations by allowing parallel processing of smaller subsets." It is well known in the art that the successful comparison of all **single logical expressions** does not imply any possible success of the overall equivalence comparison unless certain condition (e.g., the condition in Okuzawa at Column 4 lines 61-63 as discussed above as Okuzawa's teaching away) is satisfied. It is also well known that it takes impractical amounts of resources (too much time) to compare a **single input point** at a time for equivalence comparison of complex Boolean functions because a Boolean function of N variables involves 2^N input points. For example, more than 1,000,000,000,000,000

input points, which is too many, are needed for a Boolean function of only 50 variables, which is very very small in VLSI circuits. It takes more than 30 million years to process so many input points if each input point takes 1 second. It still takes 30 years if a million processors are used in parallel. This poor efficiency is pointed out in Okuzawa at Column 1, lines 54-57.

As stated in the above Levengood case,

> "That one can *reconstruct* and/or explain the theoretical mechanism of an invention by means of logic and sound scientific reasoning does not afford the basis for an obviousness conclusion unless that logic and reasoning also supplies sufficient impetus to have led one of ordinary skill in the art to combine the teachings of the references to make the claimed invention."

Applicant therefore submits that combining Okuzawa, Tucker and MPEP 2144.04(VI)(B) is not legally justified and is therefore improper. Thus Applicant submits that the rejection on these references is also improper and should be withdrawn.

Applicant respectfully request, if the claims are again rejected upon any combination of references, that the Examiner include an explanation, in accordance with M.P.E.P. 706.02, Ex parte Clapp, 227 U.S.P.Q. 972 (B.P.A.&I. 1985), and Ex parte Levengood, supra. a "factual basis to support his conclusion that it would have been obvious" to make the combination.

The Combination Suggested In The Office Actions Would Not Be Operative

The Office Actions do not explicitly describe any operation details of the method in the combination of references. Tucker (second paragraph, page 287) discloses that a divide-and-conquer algorithm has to merge "the solution to the subproblems to construct a solution to the original problem". Tucker's 2 solutions of the mergesort example (pages 287-288) and discussion of the first Church-Rosser theorem (page 2034) show the unobviousness of this merge step. None of the references include any means to perform this merge step for "divide and conquer" for Boolean functions, and neither do the Office Actions propose any such means.

Thus Applicant submits that the prior art does not provide any operative combination of the Okuzawa, Tucker and MPEP 2144.04(VI)(B) that would have been obvious.

Even If Okuzawa, Tucker And MPEP 2144.04(VI)(B) Are Combined In The Manner Suggested In The Office Actions, The Combination Would Not Show All Of The Novel Physical Features In Claim 1

However even if the combination of Okuzawa, Tucker and MPEP 2144.04(VI)(B) were legally justified, claim 1 would still have novel (and unobvious) physical features over the combination.

Okuzawa's method takes "UPPER LEVEL LOGIC" and "LOWER LEVEL LOGIC" as the two parts of its input data, as disclosed in FIG. 1 (column 4, lines 33-36), and

none of these two parts are Boolean constants or subsets of input spaces. However, the present invention uses three parts of input data: a Boolean function, a Boolean constant and a subset of input space, and no 2 of these 3 parts play parallel roles as "UPPER LEVEL LOGIC" and "LOWER LEVEL LOGIC" do. Okuzawa's 2 parts of input data and the 3 parts of input data in the present invention clearly are not equivalent to each other. None of a Boolean function, a Boolean constant and a subset of input space are taught or suggested in Tucker or MPEP 2144.04(VI)(B), either. Claim 1 is amended to shown these novel physical features more clearly as individual limitations.

Equivalent checking with these 3 parts of input data is not known in the prior art although equivalent checking with Okuzawa's 2 parts is. Due to the difference in the input data, the equivalence being determined in the present invention is a novel physical feature that is unknown (not taught or suggested) in the prior art. Claim 19 is added to show this novel physical feature more clearly.

The Office Actions do not include any line of reasoning as to why the artisan would have found these novel parts of input data or the novel concept of equivalence to have been obvious. The Office Actions fail to include any such line of reasoning even after Applicant raised this issue repeatedly in the remarks of all amendments. According to MPEP 2143.03, "To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be

considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)."

Therefore Applicant submits that claim 1 clearly recites novel physical subject matter which distinguishes over any possible combination of Okuzawa, Tucker and MPEP 2144.04(VI)(B).

The Novel Physical Features Of Claim 1 Produce New And Unexpected Results And Hence Are Unobvious And Patentable Over These References Under U.S.C. 103

Okuzawa's method is much faster than the previous Boolean comparison methods including the ones based on "divide and conquer". The reason is that the great feature of Binary Decision Diagrams enables the "transform and compare" style, which is intuitively more efficiently than "divide and conquer". However, Binary Decision Diagram's transformations are so complex that they often fail for complex Boolean functions due to memory or time limitations. Okuzawa's efficiency advantage is lost if parallel processing is applied, and its memory requirement is not significantly reduced with parallel processing.

The present invention is also much faster than the previous Boolean comparison methods, and it can handle much larger Boolean functions. The reasons of its

advantages are its flexibility to support various granularity levels of "divide and conquer" (see Tucker, second last paragraph on page 2034), and its ability to automatically select the optimal granularity level. The flexibility comes its novel use/manipulation of constraints (i.e., subsets of input space) that enables the merge step for the subproblems (see Tucker, second paragraph on page 287). The automatic selection ability comes from using Tautology Checking instead of comparing 2 complex Boolean functions.

Conclusion

For all of the above reasons, applicant submits that the specification and claims are now in proper form, and that the claims all define patentably over the prior art. Therefore he submits that this application is now in condition for allowance, which action he respectfully solicits.

Conditional Request For Constructive Assistance

Applicant has amended the specification and claims of this application so that they are proper, definite, and define novel structure which is also unobvious. If, for any reason, this application is not believed to be in full condition for allowance, applicant respectfully requests the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. § 706.03(d) and § 707.07(j) in order that the undersigned can

place this application to allowable condition as soon as possible and without the need for further proceedings.

Very respectfully,

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